Environment Canada

A BACKGROUND REPORT

POLYCHLORINATED BIPHENYLS

IWD-AR-WPMB-81-19

WATER PLANNING AND MANAGEMENT BRANCH,
INLAND WATERS DIRECTORATE,
ATLANTIC REGION,
HALIFAX, NOVA SCOTIA

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A BACKGROUND REPORT

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POLYCHLORINATED BIPHENYLS - A BACKGROUND REPORT

1. INTRODUCTION

Polychlorinated biphenyls (PCBs)were first synthesized in 1881 and industrial production started in 1929 in many developed countries. These compounds do not occur naturally (man-made) and because of their excellent thermal and dielectric properties, stability and inertness, have been used quite a lot throughout the world. As a consequence of their wide-spread use, leakages and releases to the environment have occurred. Furthermore, their resistence to biodegradability has resulted in world wide contamination of water, sediment, soil and biota, especially between 1966 and 1976, when large amounts of PCBs were in use. Fatty tissues of animals tend to accumulate PCBs and because of their toxicity, a wide range of adverse health effects have been diagnosed and reported in many different biological species.

2. PRODUCTION OF PCBs

Monsanto Chemical Company of the U.S.A. and U.K. have produced PCBs under the trade name of Aroclor, while other industrial countries like Sweden, Japan and West Germany have used different trade names. There are, and have been no PCBs manufactured in Canada, and this country's needs have been supplied by Monsanto of the U.S.A. Between 1964 and 1975 inclusive, 17,295 tons were imported for use as heat transfer fluid, hydraulic lubricants, transformers, capacitors and plasticizer applications.

Transformers and capacitors alone accounted for 14,672 tons of the allocation. Tables 1 ands 2 show the distribution of PCBs in the Atlantic Provinces.

Table 1

PCB Distribution by Equipment and Storage (litres)

	N.B.	N.S.	P.E.I.	Nfld.	Total
Labelled as of Aug. 15,1980					
in transformers	153632	201505	4387	106153	465677
in capacitors	1920	6234	509	3928	12591
in storage	637	816	-	4942	6395
Total	156189	208555	4896	115023	484663
Projected totals in use					
in transformers	181132	219503	4387	140808	545830
in capacitors	12030	16534	509	4871	33944
Total	193162	236037	4896	145679	579774

Source: Personal Communication, EPS, Atlantic Region, February, 1981

Table 2

PCB Distribution by Sector (%)

	N.B.	N.S.	P.E.I.	Nfld.	Total
Pulp and Paper	61.0	61.2	-	36.1	54.3
Utility	18.9	7.8	17.6	47.4	21.5
Refining	0.1	1.0	-	-	0.4
Mining/Smelting	0.1	1.0	-	4.8	1.6
Chemical	0.1	5.1	-	8.3	4.2
Cement Mfg.	12.7	-	-	-	4.3
Steel	-	12.1	-	-	4.9
Rubber	-	3.6	-	-	1.4
Textile	-	1.9	-	-	0.8
School/Hospital	1.5	2.0	57.1	0.5	1.9
Food Handling/Mfg.	4.4	0.2	8.3	-	1.6
Fed./Prov. Install.	0.2	3.8	17.0	2.9	2.5

Source: Personal Communication, EPS, Atlantic Region, February, 1981

By examining Table 1, it is noted that Nova Scotia has the greatest amount of PCBs in equipment and storage. Lesser amounts are found, in decreasing order, in New Brunswick, Newfoundland and Prince Edward Island.

From Table 2, it can be seen that approximately 61% of PCBs in Nova Scotia and New Brunswick are associated with the pulp and paper industry, whereas in Newfoundland the distribution is approximately 47 percent for utility and 36% for pulp and paper.

The industrial preparation of biphenyl is carried out by passing benzene vapour over a heated catalyst. The chlorination of biphenyl is done commercially by using anhydrous chlorine in the presence of iron filings or ferric chloride as a catalyst. The crude reaction mixture is usually purified to remove colour, hydrogen chloride and catalyst. This is usually accomplished by treatment with alkali and followed by distillation. No other compounds have been found in the mixtures in any significance. However, trace quantities of polychloronapthalenes and polybenzofurans have been identified. The latter compounds are well known among chemists for their extreme toxicity.

3. PHYSICAL AND CHEMICAL PROPERTIES

After the above treatment, an intricate mixture of chlorobiphenyls results, with different numbers of chlorine atoms attached to each molecule, in addition to the presence of isomers. Many of these commercial mixtures are mobile oils at room temperature, whereas most of the individual chlorobiphenyls are solids. For example, Aroclor 1221, 1232, 1242, and 1248 and mobile oils; Aroclor 1254 is a sticky liquid, and Aroclor 1260 and 1262 are sticky resins.

Aroclor products are identified by a four digit numbering system. The first two digits represent the type of molecule. For example, the number 12 indicates a chlorinated biphenyl, whereas 54 represents a chlorinated terphenyl (three phenyl rings). The last two digits indicate the weight percent of chlorine in the mixture. Aroclor 1221 contains approximately 21 percent chlorine in the polychlorinated biphenyl preparation. (However, in recent years a new product was put on the market called Aroclor 1016, which

contains 41 per cent chlorine and does not follow the above identification system).

The molecular formula of PCB is $C_{12}H_{10-n}Cl_n$, where n is the number of chlorine atoms, which replaces hydrogen atoms in the biphenyl molecular structure. Table 3 indicates the composition of PCB components in some Aroclors.

Table 3

Approximate Molecular Composition of Aroclors

Chlorobiphenyl	1221	1242	1254	1016
$C_{12}H_{10}$	11	0.1	0.1	0.1
$C_{12}H_9Cl$	51	1	0.1	1
$C_{12}H_8Cl_2$	32	16	0.5	20
$C_{12}H_7Cl_3$	4	49	1	57
$C_{12}H_6Cl_4$	2	25	21	21
$C_{12}H_5Cl_5$	0.5	8	48	1
$C_{12}H_4Cl_6$	ND	1	23	0.1
$C_{12}H_3Cl_7$	ND	ND	ND	ND
$C_{12}H_1Cl_9$	ND	ND	ND	ND
$C_{12}Cl_{10}$	ND	ND	ND	ND

*ND - Denotes non-detectable

Source: Hurtzinger, et al, 1974

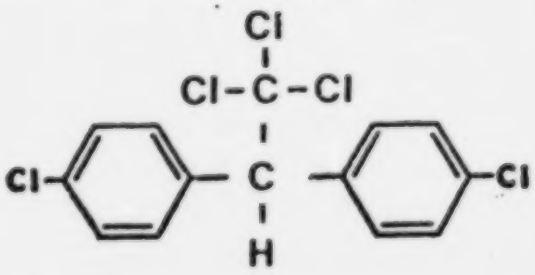
With respect to some of their physical properties, the specific gravity of PCBs ranges from 1.2 to 1.8 and they are therefore, heavier than water. From an environmental point of view probably the most significant physical properties are solubility and vapour pressure. PCBs are quite soluble in most organic solvents, oils and lipids (fatty tissues). Their solubility in water is low and it decreases as the number of chlorine atoms increases. Table 4 indicates the solubility in water of some of the common Aroclors, DDT, and includes as well the molecular weight, percent chlorine and vapour pressure.

Chemically, PCBs are exceptionally stable compounds. They resist oxidation, the action of acids and bases, and possess low reactivity toward other chemicals. They persist in the environment because of their resistance to biodegradability. The higher the proportion of chlorine, the longer their persistence. Precise information is lacking as to the residual time of these compounds in the environment before they are either broken down into intermediates (metabolites) or completely into HCl and CO_2. It is known that lower chlorinated biphenyls require less time for degradation than the higher ones.

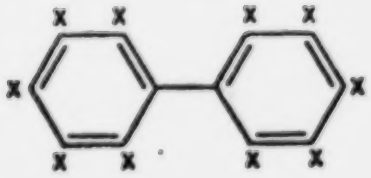
Table 4

Comparative Physical Properties of PCBs and DDT (After NISBET and Sarofim, 1972)

		Aroclor				DDT
		1242	1248	1254	1260	
Molecular Weight	Range	154-358	222-358	290-392	324-460	352
	Average	262	288	324	370	352
% Chlorine, Solubility in H_2O (at 20°C, (µg/l)		42 200	48 100	54 50	60 24 Est.	50 0.7
Vapor Pressure at 38°C (mm, Hg)		10^{-3}	3.7×10^{-4}	6×10^{-5}	2×10^{-7}	2×10^{-5}
Vapor Pressure at 20°C (mm, Hg)		10^{-4}	3×10^{-5}	3.6×10^{-6}	1.5×10^{-7}	



DDT



PCB

(X-Chlorination site)

4. USES

PCBs are good conductors of heat, poor conductors of electricity and have the ability to withstand heat. Because of these properties, they have been used widely in heat transfer equipment, in transformers and capacitors as dielectrics, and as fire retardents. In addition, PCBs have been used extensively in other products. The former uses with respect to the grade of Aroclors, is shown below in Table 5.

Table 5

Former Uses of PCBs	Aroclors
Hydraulic fluids	1232, 1242, 1248, 1254, 1260
Plasticizer in synthetic resins	1248, 1254, 1260, 1262, 1268
Adhesives	1221, 1232, 1242, 1248, 1254
Plasticizer in rubbers	1221, 1232, 1242, 1248, 1254, 1268
Heat transfer systems	1242
Wax extenders	1242, 1254, 1268
Dusting agents	1254, 1260
Pesticide extenders, inks, lubricants, cutting oils	1254
Carbonless reproducing paper	1242

Source: Hurtzinger et al, 1974

5. ENTRY OF PCBs INTO THE ENVIRONMENT

PCBs may enter the environment through accidental leakages when in transit to the disposal sites. At landfill sites leachates containing PCBs can contaminate groundwater by seepage and surface water by run-off. Vaporisation and burning of materials containing PCBs is a source of atmospheric pollution. PCBs are subsequently returned to the earth as precipitation and/or dry particles. In the manufacture of these compounds, spills and losses can occur. Leaks from "sealed" transformers, heat exchangers and from partially sealed hydraulic systems are known sources of PCB entry into the environment.

In the Atlantic Provinces potential inputs of PCBs into coastal or freshwater environments are:

1. Spillage or dumping of PCB - containing fluids, primarily spent transformers and capacitors fluids.

2. Addition of treated and untreated municipal and industrial waste into water systems.

3. Leaching from landfill sites and industrial waste disposal sites.

4. Vaporization and subsequent local fall-out from burning solid waste disposal sites.

5. Long range aerial transport

Source: (Travers and Wilson, 1974)

6. PCB LEVELS IN THE ENVIRONMENT

Numerous investigators have analysed PCB in air, water, sediment, fish and wildlife and humans since 1970. This report will include some general statistics for North America, while a more detailed analysis will be presented for the Atlantic Provinces.

6.1 Air

The weighted average of 35 rain samples collected in Chicago and on Beaver Island gave a result of 111 ng/liter (111 nonagrams per liter) or 111 parts per trillion of PCBs. (Murphy, 1978). This would indicate a fallout of 4800 kg per year of PCBs to Lake Michigan. Most of the PCBs in rainwater were there as vapor, while a small amount was in the form of particulates.

Harvey and Steiner (1974) found atmospheric PCB levels of 0.05 ng/m^3 on the Grand Banks and that the levels decreased expotentially as the distance increased from the east coast of the United States.

Analysis of samples of fish from Lake Minto in the eastern Canadian Arctic gave results ranging from 0.59 to 12ppm (Riseborough 1971). It is believed that this lake had not witnesseed any previous human intrusion and that aerial transport and fallout was the only source of PCB contamination. It was assumed that these levels were reflective of the background levels at that particular latitude.

6.2 Water and Wastewater

At the International Conference on Environmental Sensing and Assessment at Las Vegas, September, 1975, it was disclosed that as a result of surveys carried out in the United States, PCB levels in groundwater ranged from 0.1 - 4.0 mg/l.

Raw sewage from four major areas in Ontario was treated in six activated sludge treatment plants (Lawrence, 1977). PCB levels in 36 samples collected from all six plants gave values ranging from 1.5 ppb to 27.3 ppb (parts per billion). PCBs in sludge from the sludge digestion plant were concentrated to values as high as 2085 ppb. Stricter control for sludge disposal, especially on land, was recommended.

In 1974, thirty-three municipalities were studied with regard to PCB concentrations in wastewaters (Marsalek, 1978). It was determined that PCB levels ranged from 0.1 ppb to 1.8 ppb and that the industrial areas of Toronto, Hamilton and Windsor had the highest concentrations. The primary facilities of the treatment plants removed about 50 percent; the secondary facilities removed about 60 percent and; disgested sludges concentrated the the PCB levels in the range of 0.6 to 76.6 ppm calculated on the dry basis. The process of removing PCB from raw sewage was accumulation, as there was

no evidence that PCB biodegration was operating. The quantities of PCBs discharged in the effluent (mostly Aroclor 1254 and 1260) from the thirty three waste water treatment plants were 264 kg/yr or 67 mg per capita per year.

Toilet paper samples were found to contain PCB levels ranging from trace amounts to a high of 21 µg/g (Williams, 1979). Thus, paper containing PCBs and disposed of in sewer systems are potential contributors of the contaminant to water resources.

PCB levels in burbot (an eel-like fish) liver below the power plant in the trail race at Churchill Falls, Labrador, were twice as high as those tested upstream of the plant (Musial et al 1978). Tail race values were in the range of 1.2 to 35.4 µg/g with a mean of 17.1 µg/g. Upstream values were in the range of 0.04 to 1.11 µg/g with a mean of 0.49 µg/g. Whether the contaminant had leaked from the power plant or seeped from a nearby garbage disposal area had not been confirmed.

6.3 Sediment

Sediment samples were collected from the Upper Great Lakes in the summer of 1974 and analysed for PCBs and other contaminants (Glooschenko, 1974). PCBs were detected in all sediment samples.

Bottom mud and fish samples collected between mid-April and mid-October 1971 from water courses draining agricultural land in Ontario gave results of 217 ppm and 0.4 ppm respectively (Miles and Harris, 1971).

In southwestern Nova Scotia sediment samples from ten fish processing sites, three control sites and two boating sites were collected (May to August 1978) and analysed for PCB levels and total volatile solids (Wiltshire, 1978). Based on the analyses it was found that fish waste, as a result of normal fish processing activities, contributed to PCB levels in sediment to the extent of 100 ppb. Any excess above this level was attributed to boating activities.

PCB concentrations in Halifax Harbour sediments ranged from 17 to 800 µg/kg, Saint John, N.B. Harbour sediments ranged from 10 to 610 µg/kg, and at St. John's the range was 540 to 4900 µg/kg, according to a survey carried out in the autumn of 1976 (Travers and Wilson, 1977). Highest concentrations were found near sewer outfalls and oil tanker unloading facilities. No PCBs were detected at Chezzetcook Inlet, 20 miles from Halifax (detection threshold: 5 µg/kg).

Further information regarding PCB levels in harbour and river sediments in the Maritime Provinces is shown in Table 6.

The only industrial plant in the Atlantic Provinces known to have used PCBs in its manufacturing process is Aerovox (Canada) Ltd. of Amherst. The dielectric in the small manufactured capacitors was previously paper impregnated with Aroclor 1016. Liquid effluent was discharged to the Amherst municipal sewer system to the LaPlanche River, which flows into the Bay of Fundy. In 1976, the effluent entering the sewer system contained PCB concentrations in the 50 mg/l range and amounted to approximately 2.3 kg/yr. After September 1978, the plant was to abandon the use of PCB filled capacitors, by substituting some other material. In addition, the company is no longer permitted to discharge any waste material contaminated with PCBs at the Amherst landfill site, and any buried drums containing PCBs were to be removed and incinerated in accordance with federal and provincial regulations.

TABLE 6

1979 Sediment Results - PCB's

NAQUADAT Station #	Station Description	Date Sampled	Lab #	Analytical Results mg/Kg
53PE01CC0005	Charlottetown Harbour 80 M. S65°W from Southwestern Corner of MOT	Aug. 2/79	901155 901156 901157	0.26 0.28 0.28
53PE01CB0006	Summerside Harbour 100 M. S25°W from Southwestern Corner of Queens Wharf	Aug. 3/79	901152 901153 901154	L0.005 0.67 1.6
53PE01CB0005	Malpeque Bay 1850 M. S61°W from boat launching site at end of Beech Point Road	July 31/79	901158 901159 901160	Trace L0.005 L0.005
52NB01AR0001	St. Croix R. 150M. above bridge St. Stephen, Charlotte County	Aug. 22/79	901449 901450 901451	0.31 0.13 0.03
53NB01AP0001	Saint John Harbour (Courtenay Bay) 1250 M. WSW of Confluence of Little River, Saint John County	Aug. 31/79	901589 901590 901591	L0.005 Trace L0.005
51NB	Saint John R. at Grand Falls Dam	Aug. 29/79	901559 901560 901561	0.18 0.11 L0.005
53NB01B0001	Miramichi R. near Loggie ville, 1500 M. W. of St. Andrews Point, Northumberland County	Aug. 16/79	901487 901488 901489	Trace Trace 0.26
53NB01BL0001	Bathurst Harbour, 700 M. NNW of Daly Point, Gloucester Co.	Aug. 14/79	901484 901485 901486	0.03 Trace Trace
52NB	Nepisiquit R. 1500 M. below Old Hwy 11 Bridge	Aug. 15/79	901490	0.73
53NB01BJ0001	Restigouche R. (Dalhousie Harbour) 850 M. NW of Dalhousie Island Lighthouse, Restigouche R.	Aug. 14/79	901481 901482 901483	0.06 0.58 0.15
51NB01AJ0003	Saint John R. 150 M. above dam at Beechwood, Carleton Co.	Aug. 30/79	901562 901563 901564	0.11 Trace Trace

TABLE 6 (cont'd)

NAQUADAT Station #	Station Description	Date Sampled	Lab #	Analytical Results mg/Kg
51NB01AG0002	Aroostook River at Canada-USA Border (Center of River) Victoria County	Aug. 30/79	901592	0.07
			901593	0.1
			901594	0.1
52NS01DC0004	Annapolis River near Mochelle (at Centre), Annapolis County	Sept. 25/79	902129	Trace
			902130	L0.005
			902131	L0.005
52NS01DH0002	Salmon R. at Park Street Extension Bridge, Truro, Colchester Co.	Sept. 27/79	902132	L0.005
			902133	Trace
			902134	Trace
53NS01EJ0015	Halifax Harbour (Eastern Passage) near Shearwater Wharf, Halifax, NS	Sept. 26/79	902135	0.05
			902136	L0.005
			902137	L0.005
53NS01DP0001	Pictou Harbour near Town Point Wharf, Pictou County	Sept. 27/79	902138	L0.005
			902139	L0.005
			902140	L0.005
51NS01FB0002	Lake Ainslie 500 M. from Southerly Tip, Inverness County	Oct. 25/79	903510	L0.005
			903511	L0.005
			903512	L0.005
53NS01FJ0001	Sydney Harbour 200 M. SW of Sydney Engineering and Drydock Cape Breton County	Oct. 25/79	903513	0.06
			903514	0.05
			903515	0.01
53NS01ER0001	Chedabucto Bay, 3 Km ESE of King Point, Guyborough County	Oct. 24/79	902379	0.04
			902380	Trace
			902381	L0.005

6.4 Fish and Wildlife

In the Atlantic Region PCB levels in fish have been investigated by St. Andrews Biological Station, the Marine Ecology Laboratory of the Fisheries and Marine Service (FMS) and the Halifax Laboratory of the Fisheries Research Board (now defunct). Wildlife research into PCB residues has been undertaken by the Canadian Wildlife Service.

PCB levels in cod muscle around Canada's east coast ranged from 0.005 mg/kg to 0.060 mg/kg with an average of 0.017 mg/kg (Ices, 1976). In cod liver, PCB levels were much higher and ranged from 1.2 to 5.9 mg/kg.

Blubber samples from 18 Harp seals near the Saguenay River in the Gulf of St. Lawrence were analyzed for PCB concentrations. Test results showed a range of 2 to 22 ppm PCB. Rank correlation of residue level and age indicated a trend of increased residue level with the age of the animals. (Addison, 1973).

Based on test results, hardly any levels of PCB in the muscle of marine fish have been in excess of 2 mg/kg, and of the data available, fresh water species show lesser amounts of PCB residsue (Travers and Wilson, 1977).

Information regarding PCB levels in wildlife is shown in tables 7 and 8.

From the meagre amount of data available in Table 7 it would appear that the North American fish-eating birds were far more contaminated than their counterparts in Europe. For example, DDE concentrations in cormorant eggs dropped from 30 ppm in the Great Lakes to 8.5 ppm at two Gulf of St. Lawrence colonies (Riorden and Heron Island) to 1.9 ppm in a sizeable sample of shag eggs taken between 1962 and 1971 from two colonies in northeastern Britain. DDE and PCB levels were much higher in Gulf cormorant eggs than in British shag eggs, and the levels of the same chlorinated hydrocarbons in common tern eggs were 23 and 149 ppm near Hamilton, 0.9 and 2.4 ppm near Bathurst, and 0.2 - 0.7 and 1.6 ppm in Britain.

6.5 Humans

At the International Conference on Environmental Sensing and Assessment held at Las Vegas, September 1975, it was reported that a survey carried out on humans in 1972 showed that 3035 adipose tissue samples, out of a total of 4102, gave results which were in the approximate

TABLE 7. DDE, PCB AND TOTAL MERCURY LEVELS IN FISH-EATING BIRDS 1963-72

SPECIES	SITE	SAMPLE	TISSUE	MEAN PPM WET WEIGHT DDE	PCB	Hg	AUTHOR
Gannet	Bonaventure Is.	9	Whole egg	29.6	-		J.A. Keith
	Bonaventure Is.	10	Whole egg	14.9	5.45	-	J.A. Keith
	Bonaventure Is.	10	Brain	3.3	-	-	J.A. Keith
Gannet	Janeville, N.B.	1(dead or dying bird)	Brain and liver	49.5	81.4	3.20	P.A. Pearce
Gannet	Bathurst, N.B.	1(dead or dying bird)	Brain	1.76	4.92		P.A. Pearce
	Magdalen Is., P.Q.	1(dead or dying bird)	Brain	19.1	35.1		P.A. Pearce
Double-Crested Cormorant	Rivaden, N.B.	5	Egg	9.91	9.83	.50	P.A. Pearce
Double-Crested Cormorant	Heron Is., N.B.	10	Egg	7.84	13.2	.31	P.A. Pearce
Double-Crested Cormorant	Bay of Fundy -Manawagonish, N.B.	10	Egg	7.46	15.0	.23	P.A. Pearce
	-Flatpot Is.,N.B.	11	Egg	29.4	43.5	-	V. Zitko and P.M. Choi
	-Hospital Is.,N.B.	4	Egg	8.63	17.2	-	V. Zitko and P.M. Choi
Shag	Scotland, N.W. Coast	5	Egg	.36	<.5	-	J.L.F. Parslow, et al.
Shag	Scotland, N.W. Coast	6	Egg	2.2	5	-	I. Presst, et al.
Shag	England, N.E. Coast	5	Egg	1.6	3	-	I. Presst, et al.
Herring Gull	Bag of Fundy -Fatpot Is., N.B.	10	Egg	5.67	12.6	-	V. Zitko, et al.
	- Hospital Is.,N.B.	3	Egg	2.83	5.54		V. Zitko, et al.
	Norway W. Coast	80	Egg	1.53	1.0	-	J.B. Bjerk and G. West
Common Tern	Britain, E. Coast	8,14	Egg	.2	.7	1.6	N.W. Moore and I. Presst, et al.
	Lake Ontario	10	Egg	23.1	149	.87	P.A. Pierce, et al.

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TABLE 7 Cont'd. DDE, PCB AND TOTAL MERCURY LEVELS IN FISH-EATING BIRDS 1963-72

SPECIES	SITE	SAMPLE	TISSUE	MEAN PPM WET WEIGHT DDE	PCB	Hg	AUTHOR
Common Puffin	Avalon Pen.	5	Whole body immature	.25	.39	-	J.A. Keith and I.M. Gruchy
	Labrador	10	Muscle	.29	.41	-	J.A. Keith
	Labrador	10	Muscle	.30	.31	-	J.A. Keith
	Scotland,S.W. Coast	9	Egg	2.0	8	-	I. Presst

SOURCE: Toxic Chemicals in Living Things in the Gulf of St. Lawrence, by Pearce et al., 1973.

TABLE 8

DDE* AND PCB LEVELS IN BLUBBER AND TOTAL MERCURY LEVELS IN LIVER OF MARINE MAMMALS, 1965-71

SPECIES	SITE	NO. OF SAMPLES	AGE	MEAN ppm WET WEIGHT DDE	PCB	Hg	AUTHOR
Harp Seal	Tadoussac - Escoumains	18,18,20	1-18 yrs	6.32	8.17	3.63	R.F. Addison and F.A.J. Armstrong
	Amherst Is.	7	Pup	1.87	3.39	-	A.V. Holden
	Magdalen Is.	3	Pup	1.94	2.19	.26	F.A.J. Armstrong
	Newfoundland/Labrador	6	Pup	.58	1.2	-	A.V. Holden
	Jan Mayen Area	7	Pup	.50	1.5	-	A.V. Holden
	Barents Sea	5	Pup	.94	1.74	-	A.V. Holden
Hood Seal	Magdalen Is.	1,1,3	Adult, Adult 8-13 yrs	3.5	3	37.2	A.V. Holden and F.A.J. Armstrong
Gray Seal	Sable Is.	5,5,11	Adult	24.9	27	88.2	
	England East	2	Adult	16.4	123	-	
	Scotland East	16	Adult	9.7	38		
Harbour Porpoise	Bay of Fundy - Lorneville	1	-	104	223	-	D. Gaskin
	Gulf of Maine - Boothbay Harbour	1		49.3	91	1.13	D. Gaskin

SOURCE: Toxic Chemicals in Living Things in the Gulf of St. Laurence by Pearce et al.

*DDE is an isomer of DDT

range of 1 ppm PCB to 3 ppm (Ruopp, 1975). Similar results were obtained from a survey in 1973. Levels of PCB in humans reported for the Atlantic Region, Canada, averaged .727 mg/kg, which was lower than the national average of 0.907 mg/kg (Mes et al 1977).

7. ENVIRONMENTAL AND HEALTH EFFECTS

The primary danger with PCBs is that the levels increase in organisms by the process of bioaccumulation. The concentration of PCBs increases in organisms with progression up the food chain. For example, freshwater and marine plants extract PCBs from water, then fish and other animals increase their levels of PCBs from food which is eaten, in addition to that extracted from the physical environment. The accumulation of PCBs in microscopic plants is dangerous and when a certain level is obtained it may prevent the photosynthetic process, on which all marine life depends, from taking place. Furthermore, at the top of the food chain, PCBs, for example, may reach levels where they could cause interference with the reproductive systems of fish.

8. TOLERABLE LIMITS OF PCBs

The U.S. Food and Drug Administration (FDA) has set a tentative acceptable daily intake for man at 150-300 μg/day. Supposedly, the control of intake of PCBs is achieved by regulating the permissible amounts in food. The following is a list of food products with the allowable PCB concentrations: milk and dairy products of 1.5 mg/kg (fat basis), poultry 3 mg/kg, eggs 0.3 mg/kg, fish and shellfish 2 mg/kg. The United States Environmental Protection Agency (EPA) has suggested a value of 0.001 mg/l in water, for freshwater and marine life, so that accumulation in tissues would not exceed the maximum permissible amount. The Department of Health and Welfare has set a limit of 2 mg/kg for fish which is sold in Canada for human consumption. If it were assumed that a person consumed 2 lbs of fish per week, (approx. 0.9 kg), this would amount to a weekly intake of 1.8 mg, or 257 μg PCB daily.

9. REGULATORY CONTROL

The Environmental Impact Control Directorate of EPS has established guidelines (1978) on central collection and storage facilities for waste materials contaminated with PCBs. The report outlines the criteria for site selection, materials and labour requirements, equipment, safety and emergency procedures. These federal guidelines are not intended to affect or replace any existing provincial or municipal regulations. They will be updated as more PCB information becomes available.

The control of PCB uses is regulated under the Environmental Contaminants Act. A copy of chlorobiphenyl regulation No. 1 Amendment is attached, dated June 20, 1980. In addition, there are other acts relevant to the control of PCBs, namely the Fisheries Act and the Clean Air Act. Provincial governments have similar acts.

10. TREATMENT TECHNOLOGY

Incineration appears to be the best treatment technology for the destruction of PCBs in waste liquids, scrap oils and solids. The incinerators are required to operate at temperatures ranging from 1000°C to 1300°C with a PCB residence time of 2 to 3 seconds. There are no official incinerators operating in Canada for the destruction of PCBs. However, a decision as to the suitability of cement kilns will be made after a federal government/industry task force review presently being carried out. Research is also proceeding in Ontario sponsored by the federal government, with respect to the suitability of mobile incineration units. A recommendation regarding the best mode of destruction should be available in 3 to 5 years time.

PCB levels in wastewaters can be reduced to the 1ppb level by absorbents such as activated carbon and macroreticular polymer resins. Carbon absorption was shown to be the best available technology when using a pilot-plant scale set-up, whereas the ultra-violet ozonation technique was demonstrated to be the best laboratory technique, and it also had the potential of converting PCBs to CO_2, H_2O and HCl (Contos et al 1976).

Table 9 shows capital and operational costs (1976) for an activated carbon absorption system.

Table 9

Activated Carbon Absorption System

1. Annual Operating Cost

Cost/1000 US Gal.	$1.79	$1.17	$.88	$0.67	$0.52	$0.41	$0.37

2. Installed Costs

Total Absorption System Cost ($1,000)	32	42	66	86	138	236	708
Flow (US gpm)	20	40	80	160	320	640	1700

Source: Contos, et al, 1976

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